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AF, NASA achieve rocket engine milestones

as submitted by the Propulsion Directorate

EDWARDS AIR FORCE BASE, Calif. — The U.S. Air Force, NASA, and two prime aerospace contractors have successfully completed testing of two key rocket engine components.

Testing of a new, liquid-hydrogen turbopump and a unique oxidizer preburner is part of a program called the Integrated Powerhead Demonstrator (IPD). The program is a joint venture between the Integrated High Payoff Rocket Propulsion Technology program, managed for the Department of Defense by the Air Force Research Laboratory's Propulsion Directorate at Edwards Air Force Base, Calif. and NASA's Next Generation Launch Technology program, managed for the Agency at the Marshall Space Flight Center in Huntsville, Ala.

Both tests are part of component-level, risk-reduction studies, intended to lead to development of a unique hydrogen-fueled, full-flow, staged-combustion rocket engine. The engine will use preburners for both oxygen-rich and hydrogen-rich staged combustion. This will help the rocket engines operate at cooler temperatures during flight while achieving higher engine efficiencies and reducing their exhaust emissions.

"Completion of these tests moves us two steps closer to full-scale, integrated testing of the entire IPD system," said Garry Lyles, manager of the Next Generation Launch Technology program, which manages the IPD project for NASA. "America's future in space hinges on cutting-edge technology development, and together with our Air Force and industry partners, we're focused on creating a more reliable, robust engine system."

The team's integrated system testing is scheduled to begin in late 2004 at NASA's Stennis Space Center near Bay St. Louis, Miss.

The liquid-hydrogen fuel turbopump was developed for the Air Force and NASA by the Rocketdyne Propulsion and Power division of the Boeing Company of Canoga Park, Calif. The last of the turbopump test series, conducted at the Stennis Space Center, was completed Oct. 29.

The turbopump is designed to provide high-pressure hydrogen to the rocket engine thrust chamber, enabling the combustion process and generating thrust. The turbopump extracts energy from hot gases, which are generated by the fuel preburner and flow through the turbine, causing the turbopump rotor to spin at more than 50,000 rpm. As the rotor spins, an impeller attached to the other end of the shaft pumps the hydrogen to pressures greater than 6,600 pounds per square inch. These high pressures are necessary to generate the 3,000-psi combustion gases in the thrust chamber, which expand through the chamber and nozzle to produce 250,000 pounds of thrust.

The design and technologies of the fuel turbopump address key life limitations of current reusable rocket engines, and is intended to achieve a lifespan goal of 200 flight missions and 100 flights between periods of engine refurbishment — 10 times the current capability of reusable rocket engines.

"We are very pleased with the results of the turbopump testing," said Don McAlister, IPD program manager at Boeing Rocketdyne. "We've met all our objectives and we've learned valuable lessons for future rocket engine design and testing. With the turbopumps well characterized, we can now move confidently into engine system testing next year."

Testing of the oxidizer preburner was conducted by component designer Aerojet Corp. at its Sacramento, Calif. facilities. That test series was completed Oct. 28.

The oxidizer preburner — which initiates the combustion process — is designed to generate oxygen-rich steam for use by the oxygen turbopump's turbine. The preburner burns a large quantity of liquid oxygen with a small quantity of hydrogen to produce this steam, which then mixes with additional hydrogen fuel to be burned in the main combustion chamber.

The preburner is the first flight-capable, oxygen-rich preburner developed in the United States for a large-scale engine. The use of oxygen-rich steam to power the oxygen turbopump is intended to dramati-

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cally increase safety of engine system operation, limiting seal failure between the pump and the turbine that could leak extremely hot gases into the turbine and cause them to burn prematurely.

"We are very excited about the operating characteristics demonstrated during the preburner testing," said Robert Werling, project manager for Aerojet. "They provided the thermal environments required to meet the extended turbine life goals, while providing the power necessary to realize the performance goals of the integrated engine system."

The Integrated Powerhead Demonstrator program is already seeing technology application as the cornerstone of NASA's Next Generation Launch Technology program, which seeks to provide safe, dependable, cost-cutting technologies for future space launch systems, increasing engine operability and leading to aircraft-like flight operations.

The Integrated Powerhead Demonstration program is an important part of the Department of Defense's Integrated High Payoff Rocket Propulsion Technology (IHPRPT) program, which seeks to double the performance and capability of today's state-of-the-art rocket propulsion systems while decreasing costs associated with military and commercial access to space. **@**